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The role of community social capital for food security following an extreme weather event

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ABSTRACT

The current climate change trajectory is expected to increase the frequency and intensity of extreme weather events (EWE), which have the potential to influence community food security. This research explores the influence of social capital on U.S. rural community responses to an EWE, and its impact on community food security. After the 2011 EWE Tropical Storm Irene in VT, both bonding and bridging social capital influenced rural community responses to the EWE. Communities with high levels of social capital prior to the EWE led to effective action improving and stabilizing community food security immediately after the event. However, low levels of social capital prior to the EWE did not negatively affect community response when bridging social capital was engaged by a central community actor during and after the EWE. Our findings indicate that rural communities with high levels of bonding and/or bridging social capital facilitates a collective community response to short-term community food security during and after an EWE. The findings also show that a community's sense of place is different depending on the level of community social capital present prior to an EWE. We discovered a connection between a rural community's access to and effective use of physical capital to help mitigate community food insecurity, and that community's level of bonding and bridging social capital prior to the EWE. We suggest areas for future research to investigate how rural social capital can help build/maintain physical capital to increase rural resiliency and expand adaptation capacity. As such, we suggest that promoting the use and development of social capital can build resiliency and adaptation to future EWE by promoting the growth of community social capital, both bonding and bridging, within rural communities.

1. Introduction

Climate change is projected to affect virtually every region in the world (IPCC Core Writing Team et al., 2014; NASA, 2017), though with varying impacts and uncertainties. Importantly, climate change impacts are predicted (and in some cases likely already begun (Barnosky et al., 2012; Rockstrom et al., 2009) even if the most plausible and effective climate change mitigation strategies were deployed today. Among many other potential impacts, it is predicted to influence food security globally across the food system, with impacts ranging from reduced yields in agricultural production to disruptions in food transportation and storage (Brown et al., 2015). Impacts are expected to hit the poorest people especially hard (Anthony and Woodruff, 2004; Hanjra and Qureshi, 2010), albeit with individuals and societies having different potential adaptive capacities (Smit and Wandel, 2006). In the U.S., poverty rates are on average higher in rural areas than metro areas (USDA ERS, 2017), and climate change will impact the poor by increasing the percentage of total necessary household expenditures, including food and water, thus widening the economic consequences from climate change effects (Morello-Frosch et al., 2011).

One key impact is a projected increase throughout the 21st century of extreme weather events (EWE), defined as a weather occurrence "rare or rarer than the 10th or 90th percentile", and "typically include floods and droughts" (NOAA, 2017a,b) 21st century (IPCC Core Writing Team et al., 2014, p. 151). Evidence indicates that EWE will impact food production, food distribution and infrastructure, and incidences of food emergencies in both rural and urban areas (Brown et al., 2015; FAO, 2010; Wheeler and von Braun, 2013). EWE also have the potential to create acute food shortages (Gbegbelegbe et al., 2014) and disconnect communities as infrastructure and transportation systems may be compromised (IPCC Core Writing Team et al., 2014). For rural communities, these potential impacts could be particularly challenging,

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as such communities are often already isolated, making them more vulnerable to receiving assistance following a disaster. Nevertheless, recent climate change research (Ingold, 2017; Jones et al., 2012; Larson et al., 2017) (Jones et al., 2012; Larson et al., 2017; Ingold, 2017) has demonstrated that social capital – the trust, reciprocity, and relations between people - may be critical for both food security (Tibesigwa et al., 2016) and for responding to disasters (Hawkins and Maurer, 2009; Ludin and Arbon, 2017). Given the projected increase in such events both in the U.S. and globally, here we explore the relationship of social capital in three rural communities and its relationship to community response to food insecurities following a EWE.

2. Background

2.1. Social capital

In the last few decades, community in relation to social capital has been researched by social scientists and governments (Butcher, 2006; Grootaert and van Bastelaer, 2001; Ostrom, 2000; Paxton, 1999; Portes, 1998; Putnam, 2000), and in recent years, social capital is among the most studied concept in the social sciences (Engbers et al., 2017; Fragkandreas, 2012). (For a more in-depth look into a "sense of community" see American Journal of Community Psychology, volume 59, issues 3–4 (2017)). Though the term "social capital" has been reinvented six times (Putnam, 2000, p. 19), a constant is that social capital refers to the connections among individuals who join or form groups with other individuals - the social networks, trust, and reciprocity that arise from these groups comprises a concept of community social capital. To best conceptualize community social capital for this study, we build off Colman's definition of social capital; "unlike other forms of capital, social capital inheres in the *structure of relations* between actors and among actors" (Coleman, 1988; italics added). In other words, community social capital is concerned with the function of social capital within certain community structures, and how individuals can wield social capital, either sought out or received, to eventually harmonize individual interests with community needs (Flora, 1998). Here we define community social capital as the existing relations among persons (Coleman, 1988) to facilitate the "norms and networks that enable people to act collectively" (Woolcock and Narayan, 2000). These relations during collective action enable actors to share "knowledge, understandings, norms, rules, and expectations" about group interactions (Ostrom, 2000). It is the shared understandings that determine the perceptions of other individuals and groups, and the sense of mutual trust, reciprocity, collective identity, and a sense of a shared future among the community (Flora and Flora, 2013, p. 11).

There are two forms of social capital in which core community elements can be placed - "bridging" and "bonding". Bonding social capital lessens transaction costs by streamlining access to resources though homogeneity - demographic, ideological, or otherwise. Common examples of bonding social capital, often at smaller and localized scales, are found within family and kinship, church and religion, business and investment groups, political organizations, and non-governmental organizations and clubs, to name a few. It is the connections among groups and individuals with similar backgrounds that act as the driver for reciprocity within groups and mobilizing solidarity within a community (Flora and Flora, 2013; Hofferth and Iceland, 1998; Putnam, 2000).

Bridging social capital are the ties to those not within the inner circle of closely related groups. Bridging social capital is commonly found with economic and other external ties, in legal and formal institutions, and can differ greatly between regional and cultural differences. Bridging social capital connects diverse groups within and outside the community at the household, neighborhood, government and non-governmental, and township level, and can act as a counter to outgroup antagonism (Flora and Flora, 2013; Putnam, 2000). Bridging social capital can be important in the case of managing of collective resources, and in the absence of government presence.

2.2. Social capital and climate change

A large body of work has focused on social capital as a necessary component of climate change adaptation for multiple reasons (Adger, 2003; Patel, 2013). First, it is widely accepted that without social capital, other capitals - natural, cultural, human, political, financial, and built - cannot be fully developed, employed, or adapted. Second, social capital is the social cohesion necessary for community adaptation and resilience to take effect (Adger, 2003; Flora and Flora, 2013; Grootaert and van Bastelaer, 2001; Ostrom, 2000). Social capital allows communities to utilize mechanisms for collective resolution, community advancement, and widening awareness of interconnectedness. Community attitudes and perceptions also shape social capital; groups within communities perceiving higher levels of social capital are likely to engage in climate change mitigation and/or adaptation strategies (Macias and Williams, 2016), which is critical since adaptation requires collective action in the face of risk (Noblet, et al., 2016; Wolf et al., 2010). Though it is understood that increased social capital strengthens community resilience and adaptation in response to EWE (Ebi, 2011; Semenza et al., 1996), social capital is not well integrated in U.S. disaster and climate change policy research (Hawkins and Maurer, 2009).

2.3. Social capital and food security

While social capital has had a deep focus for climate change adaptation, it has only recently been recognized for its role in food security. State mitigation strategies, to some extent, do recognize social capital is necessary for community adaptation and resilience to effectively lessen the impacts of climate change on food security (Hogue and Baquet, 2016; Sander-Regier et al., 2009), and research shows food insecurity is not so much an issue of quantity and infrastructure as it is about community access and coordination (Flora and Flora, 2013; Morton and Blanchard, 2007). This is supported by the idea that food insecurity within a community places the individual's ability to access a community resource into the realm of community food security – they must be able to engage with the broader community (Burkley et al., 2011; Garasky and Stewart, 2007). For example, food resources allocated to communities though organized state and non-governmental distribution methods (e.g. SNAP, WIC, food pantries/banks, charity food distribution) are often shared in a reciprocal manner using social capital. One study showed that knowledge of both formal and informal food resources is more often shared within circles of friends, family, and neighbors (Morton et al., 2008). Additional research has found that group membership was an important factor for smallholder households in low-income countries facing different climate impacts (Brown et al., 2015; Niles and Brown, 2017). Thus, social capital may be a critical factor for food security both within normal conditions, and in the context of EWE and climate changes.

2.4. Connecting social capital, climate change and rural food security

The Food and Agriculture Organization defines food security as occurring when "all people, at all times, have physical, social, and economic access to sufficient, safe and nutritious food which meets their dietary needs and food preferences for an active and healthy life". Food security is upheld by four pillars including availability, access, utilization, and stability (FAO, 2008a,b; FAO, 2017). It is expected that climate change, including EWEs, will impact the stability of food security within all four pillars across the world (Brown et al., 2015; Niles et al., 2017). If food availability, access, utilization, and stability in regional food systems are disrupted from an EWE, the ability to have safe, nutritious food becomes challenging, and rising food prices may cause marginally food secure community members to be more vulnerable to issues such as individual and community health (Dodge et al.,

2013).

Such potential future challenges to food security come on top of already existing rural food insecurity challenges. An estimated 12.7% of U.S. households are food insecure during some time of the year (USDA ERS, 2016a,b,c). U.S. rural households have the highest rates of food insecurity at 17%–4.3% higher than the national average (Coleman-Jensen et al., 2015). Of the top 10% of the most food insecure counties in the U.S., 54% are rural (Gundersen et al., 2015; U.S. Census Bureau, 2015). Factors associated with rural food insecurity are myriad. Many parts of the rural U.S. are considered food deserts – a significant portion of U.S. county populations live more than one mile from a food store and/or do not have adequate income to be consistently food secure (Sharkey, 2009; USDA 2009). Up to one out of three rural census tracks with high poverty rates have a mean distance of > 10 miles to a food source (McEntee and Agyeman, 2010). Rural income rates average almost 25% less than non-rural areas, and U.S. poverty rates have remained about 3% higher than non-rural since the 1970's (USDA, 2017). Further, three out of four rural food sources are convenience stores – a food provider mostly void of affordable, healthy food options (Liese et al., 2007). These challenges are critical to understand as EWE present themselves in increasing intensity and frequency in the coming decades, which will present new challenges for food security beyond existing chronic issues.

3. Study focus and questions

We focus our study in Vermont (VT), United States, following Tropical Storm Irene (TSI), which struck VT on August 28, 2011, and was classified as an EWE. The resulting flooding from excess rainfall was the worst the state has seen since 1927. Record flood levels were recorded in over half of the flow sites where previous “100-year flood” records were broken (NOAA, 2017a,b; U.S. Department of the Interior: U.S. Geological Survey, 2014). TSI caused the most amount of statewide damage in VT's history (Vermont Public Radio, 2013). In the Northeast United States, storms like TSI, are predicted to increase in the future alongside extreme precipitation events, unpredictability for extreme flooding events (Karl et al., 2009). Anticipated EWE can significantly disrupt local and regional food systems, make transportation routes impassible, and affect food distribution centers and transport with power outages and damaged roads (Brown et al., 2015; Crimmins et al., 2016; Rosenzweig et al., 2001).

This research uses TSI in rural VT as an opportunity to investigate how an EWE affects short-term rural community food security, and how social capital may influence rural community resilience and food security responses. We focus on communities, as perceived by the interview subjects, as a collection of groups such as (but not limited to) households within a certain geographic proximity, people with an arbitrarily defined distance in radius or time traveled by car, belonging to clubs and organizations, political and religious association, geopolitical boundaries, and groups of individuals who know and interact with one another on a consistent basis and consider one another a part of their community. Succinctly, community is the existing relations among persons to facilitate the norms and networks that engage groups with trust and reciprocity. As such, we define community social capital as the generalized trust, reciprocity, common rules, norms, and sanctions/actions motivated by groups with a shared vision of the present and future needs of those groups within a given community.

We draw upon a conceptual framework, developed through the social capital literature, to explore levels of bonding and bridging community social capital in the context of EWE and food security (Fig. 1). We employ our conceptual framework to categorize perceptions of community social capital with the four types of bonding/bridging communities as conceived in the literature (Flora and Flora, 2013, p. 128; Putnam, 2000, pp. 354–355; Woolcock and Narayan, 2000). Drawing upon both this bridging/bonding framework and the theories of social capital we pose the following critical questions: What did community bonding/bridging social capital look like before TSI? Did those levels of social capital influence the community response to issues such as food security after the EWE?

	Low Bonding	+	High Bonding	
High Bridging	Community decisions based on what group outsiders offer; builds power of organization leaders, service providers, and state/federal governments; availability and stability are good, utilization and access is weak		Community decisions are made with all groups in mind; there is a concern with out-group connections; decisions are made for the common good; access and availability are good, utilization and stability is strong.	High Bridging
-				+
Low Bridging	Community suffers due to people being more concerned with themselves; poor are often excluded from resources; all four pillars are weak.		Community suffers due to low outside communication and trust; internal investments ensure those within small groups are taken care of; access is limited, availability is uncertain, stability and utilization is weak.	Low Bridging
	Low Bonding	-	High Bonding	

Fig. 1. Conceptual framework for bridging/bonding communities and food security. Adapted from Bowling Alone, by R.D. Putnam, 2000, New York, NY: Simon & Schuster. Adapted from Rural Communities, by C.B. Flora, J.L. Flora, and S.P. Gasteyer, 2015. Boulder, CO: Westview P.

4. Methods

4.1. Methodological approach

We utilized semi-structured interviews in concert with our framework (Fig. 1) in data collection, to ensure that data were reflective of community level response as opposed to collecting data on, for example, individual psychological experiences. The framework assisted in drafting cogent interview questions that helped subjects and interviewers focus on community perceptions. Interview questions were centered on the subjects' perceptions of the community. For example, we asked in various forms “who makes up your community?”, and “how did the town interact before the Tropical Storm Irene?”. While subjects often shared stories about their personal situations during the EWE, we continued to refocus the interview to how their experiences related to the interactions and perceptions of their community, the community response to the EWE, and community food security. During interviews, we verbalized ideas such as “connections” and “interactions” to ask about social capital as the term “social capital” is most used in academic research and determined as less conducive to the clarity of lay language. Institutional Review Board (CHRBSS: 16–438) approval was granted prior to recruitment and interviews from The University of Vermont. Interview recruitment began in April of 2016 in collaboration with University of Vermont Extension. We began contacting interview subjects using purposeful sampling. Purposeful sampling allows us to find representativeness of the community setting by contacting individuals who were present before, during and after TSI, and to capture heterogeneity between the selected communities (Maxwell, 2013, pp. 97–99). To participate, all interview subjects must have been present in central VT at the time TSI hit and remained in the community during the five years after the storm hit. We initially identified interview subjects through media reports covering TSI, publicly listed central VT food banks/pantries and town government officials. After an initial six directly contacted interview subjects who met the criteria were interviewed, we relied more on snowball sampling methods. After each interview we asked the subject for suggestions on community members who played a central role in the community response to TSI. We emphasized we were looking for community members who were directly involved in their town's governance, community food security, and/or community connections (both internal and external) during and after TSI. In addition, researchers used participant observation and content

Table 1
Interviews by category and location.

	Pittsfield (5*)	Plymouth (7)	Rochester (10)	Rutland (10*)	State (2)
Business owners (9)	1	2	4	1	0
Farmers (9)	0	1	1	7	0
Food Pantry/Food Bank (7)	0	1	2	1	2
Public officials/public school (5)	2	0	2	1	0
Non-governmental leaders/general community member (6)	2	3	1	0	0

*Two interviewees (one public official and one non-governmental leader) located in Rutland were included with analysis of the town of Pittsfield due to a direct bearing on Pittsfield's response to Tropical Storm Irene. Table numbers reflect post-adjustment totals.

analysis by attending TSI five-year anniversary events during the summer of 2016; a town picnic (Pittsfield), TSI documentary screening (Plymouth), and a public celebration and photo slideshow (Rochester, 2018) to gain a better sense of the issue. Attending these events also served to triangulate the interviews with historical documentation. Interviews were digitally recorded and lasted between 20 and 100 min. We interviewed a diverse range of community members in each area of study and included two interviews from the Vermont Food Bank (Table 1), until a saturation point was reached. All the recorded interviews were transcribed in Microsoft Word to enable analysis using NVivo (Version 11.3, QSR International Pty. Ltd., 2016).

Since collecting data on perceptions requires the research to be open and flexible (Maxwell, 2013), we used Strauss and Corbin's (1990) three stage grounded theory coding process. While the framework originally informed our development of questions, we utilized grounded theory to enable themes to emerge from the data. Stage one, open coding, used data to develop categories of information. After that, axial coding was applied to find interconnected categories. Then, selective coding created categories around the central phenomenon of community food security and EWE, which elucidates the aspects of social capital in the context observed. Before data coding began, the study's two researchers double-coded a small sample (n = 3) of interviews for calibration and consistency. Areas in which there was disagreement were discussed until consensus was reached on the emergent themes identified. Once calibrated, one researcher completed the remaining coding duties with the other researcher reviewing summarized coding updates to ensure coding stayed in line with the calibrated coding of both researchers. We utilized a constant comparison method of data analysis. During data analysis, major emerging themes were placed within one or more of the sections outlined in Fig. 1. Themes that did not fit within the study focus were categorized, then analyzed for other emerging themes not anticipated in the social capital framework.

4.2. Study site

We focus on the three towns of Pittsfield, Plymouth, and Rochester, VT (Fig. 2) because they are similar in their makeup and experienced similar levels of impacts from TSI. Thus, this enables an exploration of how seemingly similar towns may have different social capital and responses to TSI. Each town is distinct in that they operate under their own town governments composed of elected officials lead by a town clerk and a selectboard. All three towns are located within the geological flood zone of the Connecticut River Drainage Basin (USDA NRCS, 2016). All three towns are considered rural and have similar key demographic ranges: population size (546–1139), median income ($48,750-$65,000), number of households (290–532), and percentage of household family units consisting of two or more individuals who are related by birth, marriage, or adoption (58%–70%). As well, all three towns received FEMA public assistance funding (PAF) following TSI. Pittsfield received over $950,000, Plymouth $1.4 million, and Rochester $2.7 million in PAF (Vermont Public Radio, 2013). Each of the above PAF dollar amounts are considered commensurate relative to the town population (Table 2), and these funds indicate that each community experienced devastating effects from TSI resulting in service loss and limited access to resources for a significant amount of time. In addition to a focus on these three towns, we also conducted interviews in and around Rutland, VT, as the urban cluster nearest the three rural towns in the region of study. Two of the ten Rutland interviews had direct bearing on Plymouth, therefore some Rutland data are included as part of the Plymouth analysis.

5. Findings

5.1. Sense of place

The concept of "sense of place" emerged during most of the interviews, often expressed as an idea that the subject's community is, or was, a "special" place. Interview responses suggests that many community members had conceptions of place that ascribed symbolic, emotional, cultural, and/or physical meanings to their community (Buttimer, 1980). Most interviewees provided direct, often passionate depictions of their sense of place as summarized below. In the discussion, we associate each community's sense of place to the level of bonding/bridging social capital perceived in each community prior to TSI.

5.1.1. Pittsfield

In Pittsfield, a sense of place comes from the location of the community, as one subject described it; *"I really feel like this place is special and the people come here because of that"*. The idea that the people make their community a special place was expressed in relation to the town size. The Pittsfield interviews elude to the idea that if Pittsfield remains small (in population), it will retain the feeling of accessible community bonding. When considering the future of Pittsfield's ability to bond, one interviewee said:

> "I would like to hope that [Pittsfield is] still small enough and still – I mean because there's checks on neighbors, all that sort of thing – I hope that we're still small enough that we can be that [dependent upon one another]."

5.1.2. Plymouth

In Plymouth, interviewees attributed their sense of place to the community interaction (or lack thereof) within their community. With the closing of the school and businesses in the years prior to TSI, those who felt Plymouth's community members make the place special also recognized that the lack of community involvement in recent years had lowered their "special feeling", weakening their sense of place, as one community member succinctly stated the town is now a *"typical American community"*. This indicated historically residents perceived their community as once unique but is now experiencing fading community solidarity.

5.1.3. Rochester

Of the three communities, Rochester subjects reported the most salient "sense of place". All interviewees felt their community was "special". The source of their sense of place came from a mixture of community members and the physical location. One long-time

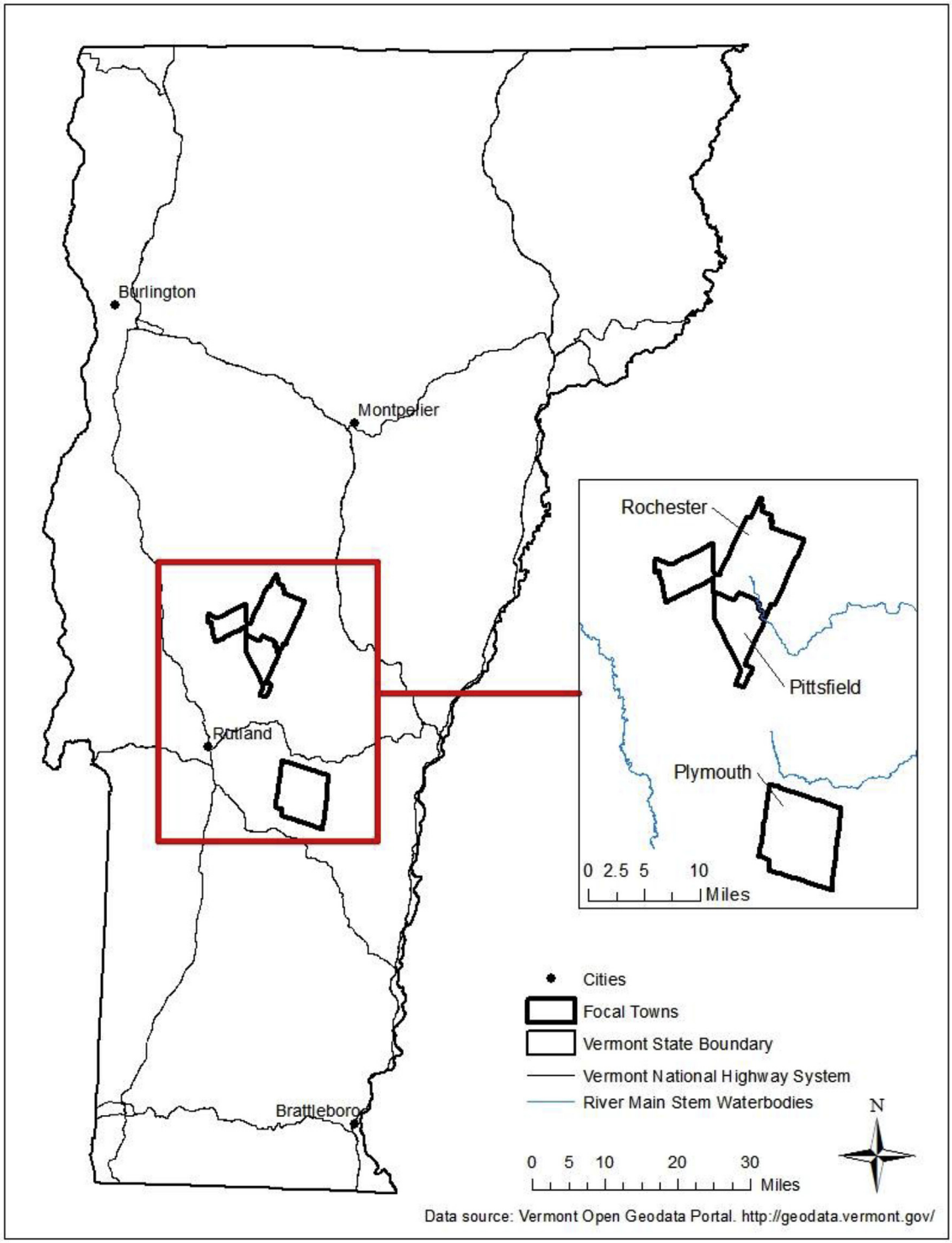

Fig. 2. Study site town boundaries. Data source: Vermont Open Geodata Portal. http//geodata.vermont.gov/.

community member went as far as to say they lived in the *"greatest place on Earth"*. Of the ten Rochester interviewees, eight stated both people and location (physical and natural capitals, combined with human and social capitals) are what make a place special. Of the other two interviews, one stated the location is what creates a sense of community, and the other said it was the people that gives their community a special feeling.

5.2. Levels of social capital

The levels of social capital were assessed using the bonding/bridging framework in Fig. 1. While we do not cite a specific working definition of "level", the framework in Fig. 1 has working definitions built into it. Depending on the subjects' responses and from which community there are from, we placed their perception, reported event, individual and community actions, and/or internal, external, individual, and community connection as reported by the interviewee into one of the four quadrants of the bonding/bridging framework. Though we do

Table 2
Key Stats for the three communities isolated by Tropical Storm Irene.

	Rochester	Pittsfield	Plymouth
Population[a]	1139	546	619
FEMA payment per capita	$1739	$2262	$2371
Family Households per capita[a]	.27	.28	.29
Vacant Housing Units per capita[a,d]	.26	.35	.93
Schools and Libraries	2	1[c]	0
Non-Governmental Organizations[b]	14	6	5
Food Pantries	1	0	1
Grocery/Food Stores[b]	2	2	0
Restaurants/Inns[b]	9	4	0

[a] American Fact Finder (2010). Retrieved March 30, 2017.
[b] Town Website and Google search. Retrieved March 30, 2017.
[c] Library was opened two years after TSI.
[d] U.S. Census definition of vacant housing unit: A housing unit is vacant if; no one is living in it (at the time of the interview), unless its occupants are only temporarily absent; a vacant unit which is entirely occupied by persons who have a usual residence elsewhere; new units not yet occupied are classified as vacant housing units if construction has reached a point where all exterior windows and doors are installed and final usable floors are in place. (See section on "Housing Unit.") Retrieved from https://www.census.gov/housing/hvs/definitions.pdf.

not determine the degree of bonding/bridging social capital, we do interpret what type of bonding/bridging social capital community data fits into, which encompasses four levels – high bonding, high bridging, low bonding, low bridging.

5.2.1. Pittsfield

Prior to TSI, data suggests Pittsfield as a high bonding/low bridging community. Pittsfield residents often bridge with nearby ski-towns through jobs and small-businesses. However, because bridging connections are primarily based on a seasonal economy, the continuity between Pittsfield and other towns is sometimes inconsistent. Though many Pittsfield residents worked and shopped outside of town, the year-round residents gravitated toward staying close to their community as one business owner commented *"our community was the small town it was, and [my business] … had a solid local community clientele that we saw pretty regularly."* Community bonding prior to TSI was indicated when a non-resident investor bought sizable portions of the town as a business venture. The community response was to oppose unsolicited ideas from an out-of-town investor, which solidified many resident's sense of place. The potential change in town commerce galvanized residents to appreciate and support local businesses, many of which are grocery stores, restaurants, inns, and taverns. The shared town identity is seen as local businesses are considered accessible to locals, unlike other towns in the region who appeal to tourists. Community bonding was also observed at the long-running annual bazaar held every fall on the town green.

5.2.2. Plymouth

Plymouth data indicates a low bonding/low bridging community prior to TSI. Three key factors contributed to this perspective: the closing of the only grocery store, the only public school, and a divisive legal issue concerning recreational land-use.

The grocery store, owned by an out-of-state, non-resident, was closed years prior to TSI. Closing the store meant the community no longer had *"opportunity for informal social cohesion"* because *"there's just no gathering place in town"*, noted one interviewee. One interviewee told of the community function the store had:

> "And just the daily interactions with a store – that's where I get my news in town. I find out what's going on. It's a chance to connect with people. That's how you build a community in those small connections."

When the town voted to close the public school for economic efficiency, many residents lost opportunity for interaction with other families. Directly tied to the school was an annual festival popular amongst locals. Today this event is held at a state park, but interviewees said the purpose has transformed to a general community event that now attracts more non-community members than Plymouth residents.

The third cited reason for low social capital was a legal battle over land access. This split community members into three camps – those wanting more recreational land access, those supporting the land owner's ethos of conservation, and those who stayed out of the debate entirely. During the ongoing debates, *"town relations were often strained"*, and communication was either contentious, or non-existent. When the town started (re)interacting after TSI, one resident summed up the sentiments about town interactions prior to the EWE: *"it shouldn't take a disaster to reach out to [your] neighbors"*.

Three lesser cited, but significant factors also indicated Plymouth had low bonding/low bridging prior to TSI. First, an annual hunting festival, no longer held, was a popular event that provided opportunity for interaction. Next, a local ski resort closed some years prior to TSI also resulting in less community interaction through employment and commerce. Finally, Plymouth has a high proportion of vacant housing units (Table 2). Some interviewees perceived these vacant homes, referred to as *"second home owners"*, as a hindrance to community involvement. Multiple subjects mentioned how the area's second home owners were absent during the recovery period after TSI. Three interviewees cited how a few second home owners, who were in Plymouth homes at the time of TSI, hired private helicopters to evacuate the area a day or two after the storm. One community member speaking of diminishing attendance at town hall meetings related the effects of the changes in Plymouth:

> "If you have a really active, vibrant, healthy community, perhaps there's more socialization and more celebration … Plymouth used to have, for instance, an annual game dinner … it was a huge event … we don't do that anymore …. There's nothing in this town really that they do, other than the town meeting – there's nothing that they do annually that is for the town, that celebrates the town, that gets people out … it's just these little sporadic events here and there."

5.2.3. Rochester

Rochester was perceived as a high bonding/high bridging social capital community prior to TSI. Abundant public events, interactions and opportunities to connect with residents and visitors occurred on a regular basis. Rochester's social capital creation occurs during the gatherings throughout the year held at the town green, public library, public school, restaurants & bars, art gallery, and downtown church. In addition to open events, many generations of Rochester families still live in town, which maintains strong bonds over time. Social capital building is formed within the numerous small, locally owned businesses that serve both the locals and tourists alike. Subjects illustrated these events as means to social capital, which manifested collectively during TSI. Five years after the EWE, the high bonding/high bridging social capital has become more apparent. To many community members, social capital has become more meaningful to the community as observed with emerged themes of appreciation, confidence, and trust in the interviews. One Rochester business owner described their sense of community then, and five years after TSI:

> "[Our community has] been made, I think, more powerful and impressive. I just love it even more. I mean, I really go to moments [during Tropical Storm Irene] … I've always really had that sense about this town, and [a strong community was] definitely pre-existing, but to see it blossom and fill out and serve such a fantastic need was really, really beautiful."

When asked about the positive attitude perceived throughout the town, one interviewee spoke of the compelling nature to become part of

the community:

> "It's something I think is deep seeded in the community from the get-go … it's almost like something that was here [when I arrived]. Those of us, the newbies, it's really funny because you'll hear all these horrific terms [elsewhere], where people are called flatlanders and stuff, nobody ever throws that out there, it was not used here … but for those of us who have [recently moved] here, the village finds us. So many people have moved here that are part of the community, and [for us] it was not a choice [to become part of the community]."

5.3. Community responses to food security

5.3.1. Pittsfield

High bonding and low bridging social capital was evident in Pittsfield's community response to TSI. The day after TSI hit, many community members arrived unannounced at the town hall. People expressed concern for Pittsfield's residents more so than their out-of-town jobs, or how other towns were fairing after the EWE. Because access to other towns was closed indefinitely, a core group of community members formed to organize recovery efforts and participate in *"old fashioned"* means of communicating through message boards and word-of-mouth. One interviewee said: *"before the roads were open, we all felt very safe … when the roads opened up, it gave a very different feel because now there were outside people coming in."* The mistrust and concern about non-community members within the town after the EWE motivated the town to set up a constable rotation to watch the *"outside people"*. Another interviewee said it was two weeks before the town felt normal with outsiders again.

Pittsfield's response had three impacts on food security during TSI. First, local food providers made food immediately available and accessible. A local food business gathered a team to cook and freely share all their food stock distributed on the town green lasting two days. Another food provider accepted "I.O.U." notes for residents who needed grocery supplies, short on cash, and/or lost ability to cook (because of power and/or home loss). Second, driven in part by bonding social capital, Pittsfield was the first town in VT to film, document and submit a written TSI FEMA report. The federal funds supported food security though long-term livelihood stability. Finally, the rapid community action by residents who owned heavy machinery able to repair roads and bridges, made damaged roads passable faster than waiting for government road crews, allowing residents access to out-of-town stores, family, jobs, and resources, many of which resulted in stabilizing both short and long-term food security.

Despite relatively inactive bridging social capital prior to TSI, data suggests that immediately after TSI, kin from Pittsfield connected to quickly form bridging social capital with another community, which played a significant role in mitigating food insecurity after TSI- bonding social capital lead to effective bridging social capital. Relatives who grew up in Pittsfield and lived in nearby towns unaffected by TSI, connected Pittsfield with community organizers in Rutland, and created what became known as the *"food train"*. The *"food train"* used rugged mountain roads through National Forest to deliver 120 truckloads of food and supplies over 10 days following TSI. Pittsfield served as the hub for *"food train"* deliveries, and the trust perceived through a shared sense of identity made possible the distribution of excess supplies to five other towns in the area. By the time the National Guard arrived with meals-ready-to-eat (MRE), Pittsfield did not need these supplies, as evident with over 15 untouched cases sitting in storage five years after TSI. One interviewee reflected on the trust and resilience of the community:

> "I think [Pittsfield] was a good, strong little community before Irene. I think the community has a better sense of community since then. A lot of people looked out for other people [in the community] during that period … all worked together to get those roads cleared off and ready for getting back into town … the National Guard came through and helped out … there were some community members that never felt that we would get to that point [of needing the help of the National Guard], and may have felt that we didn't need them [at all]."

5.3.2. Plymouth

While bridging and bonding social capital was low prior to TSI, a key community farm organization had an underlying desire to create better connections. One interviewee, who hoped to mend strained relations, viewed the disaster as a chance to make *"a generational shift in attitudes in the town."* The day after TSI, the farm organization used both on-farm and network sourced food supplies to cook meals at the town hall for 12 consecutive days, multiple meals a day, serving anyone who needed/wanted food. One organization member recalls reaching out to the town:

> "We started checking in [on the community], and said 'hey, why don't you come to dinner, we'll be cooking three meals a day, stop in', and word gradually spread around the [town]. So, we had people showing up for meals … we went down to the [town hall] to see how we could help, and just put word out there that 'hey, we're cooking three meals a day; please feel free to stop by'."

The organization further used their intra-bonding (bonding with only those affiliated with the organization) social capital to campaign and bridge their member affiliates near and far. The result amassed a volunteer corps that labored doing recovery work in the town for 6–8 weeks after TSI.

Bridging social capital also occurred at the opposite end of town. A business owner reached out to other businesses and the town's food pantry to orchestrate a centralized kitchen preparing meals for residents who lived in hard to access areas, or whose homes and/or means of preparing food were destroyed, and those repairing roads and homes. The same organizers traded surplus government food supplies with a nearby town for clothes, hygiene and cleaning supplies. By the time the National Guard dropped off MRE's a couple days after TSI, the town had mitigated known food insecurity, and thus attempted to *"wave off"* the helicopter during the NG's final MRE drop.

5.3.3. Rochester

Because of active high bonding/high bridging social capital, Rochester subjects felt they had an effective response and solidarity prior, during, and after TSI. One interviewee described how the community members responded to TSI:

> "Everybody fed everybody … the [local farms and businesses] took turns putting on meals … it was unreal, it was absolutely phenomenal. It was the most incredible humbling experience. I cannot begin to tell you how humbling it was … [volunteers who will] cook for everybody … they set up the food system for everybody in the village."

Rochester interviews depict a community mitigating food insecurity during TSI through a strong community approach. Every interviewee cited physical capital (e.g. the public school) as central to the community's resilience. During the two-weeks post-storm, the school served as the central shelter, mess hall, and food hub for the entire town. Without hesitation, businesses and community members freely brought food to the school kitchen. Organizers kept food stable with a gas powered refrigerated trailer on loan from the nearby National Forest Service station. For 10 days, meals were prepared and served from this community-pooled food stock. Subjects viewed having a school in town facilitated opportunity for all community members, with and without children, to become aware of each other's food security needs. The local food pantry was also instrumental by extending open hours for several

days after TSI. Food pantry volunteers used their social capital to help the known food insecure in the area to meet their food needs. Other food resources were saved for known large households (by way of family and/or guests) who could not access the town due to road damages. These families were ensured that food supplies could reach them through a network of shared information. The day after the storm, community members gathered food supplies to the town green where local businesses cooked meals for anyone who showed up. When asked about who attended the three days of free public meals, one interviewee replied: *"It was everybody. They just came down and had a party."*

Because of the community social capital, no perceived food insecurity was caused or worsened by TSI, and subjects attribute much of this to a *"special"* community feeling. For example, though the town had no emergency plan, by the time the National Guard dropped off pallets of MRE's, the shared food resources and prepared meals already supported community food security needs. Many local businesses delivered meals to those repairing roads and homes, including crews arriving from out of state (a display of high bridging). When state emergency relief crews arrived a few days after TSI, they shared the perspective that in no other incidence had they seen such a resilient, supportive response to a town emergency as witnessed in Rochester. One interviewee shared this outside perspective:

> "I would give [a community volunteer] a tray of [food] and say, 'go feed [the state emergency crews]. We had one [crew member] who said, 'ma'am, can I take your picture?' And [I] said, 'what!?'. And he said, 'you don't understand, when we go to other places, this doesn't happen. We don't get taken care of like this. I mean, you're walking across this little [thrown together] footbridge to hand me a cheeseburger … we're kind of amazed about that'. That's one of the things I remember, is that the medical people and the emergency workers that came in, they could not believe how [well] we were taking care of ourselves."

6. Discussion

Our findings suggest a connection between community social capital and community responses to EWE as it relates to mitigating acute community food insecurities during short-term recovery processes. Our study discovered that a community with prior low bonding and low bridging social capital (Plymouth) did not have community collective action in their response to TSI; rather, it was coordinated by a willing central actor whose leaders had a desire to strengthen community ties. Absent this central actor, it is unclear how the community would have dealt with acute food insecurities. Conversely, we find in Pittsfield, where, through the community's shared sense of place, high bonding social capital existed, the response was intra-community oriented. Though Pittsfield did not have strong, active bridging social capital prior to TSI, ties through kin and economy with nearby communities made bridging social capital quickly accessible in the days after TSI, resulting in the town's ability to uphold food security until access to other resources were available. In Rochester, where high bridging and high bonding social capital existed prior to TSI, a community oriented response to the EWE involved a diversity of people, events, and strategies. Rochester quickly pooled food resources to successfully mitigate food insecurity for community members, non-community members (outsiders), and state emergency relief crews alike. As such, in the three communities, we find evidence that different levels of bonding and bridging social capital existing prior to an EWE was significantly perceived by the community to influence the short-term community response to TSI. Below we discuss these findings in the context of the academic literature as well as the empirical implications for climate adaptation to EWE. We ground our findings in concepts of a "sense of place" and the connection between social capital and physical spaces, as well as network theories that may influence social capital and disaster responses.

While not every community in our study had high levels of social capital prior to experiencing TSI, we find that social capital was used in each community during and after the EWE. These findings support the concept that social capital benefits community resilience, adaptation, and recovery efforts after a disaster (Aldrich, 2017; Aldrich and Meyer, 2015; Clay et al., 2016; Morton and Lurie, 2013; Tompkins and Adger, 2005; Weil et al., 2012), albeit that the kinds of social capital may also be important to understand. Collective resolution was observed in the high bonding/high bridging communities (Pittsfield, Rochester) where multiple actors quickly found solutions to community food insecurity by combining private organizations and public infrastructure (i.e. public schools, churches, public parks, town halls, and businesses). As seen within fishing communities recovering after Hurricane Sandy (Clay et al., 2016) and in other work on recovery groups after TSI (Consoer and Milman, 2016), our study lends supports to the idea that community social capital allows people to utilize mechanisms for collective resolution to more easily solve problems (Putnam, 2000, pp. 288–290; Woolcock and Narayan, 2000). Consistent with research focused on Hurricane Katrina, where those with more social capital helped those in need the most (Weil et al., 2012), mutual trust, collective identity, and working together toward a shared future (Flora and Flora, 2013, p. 11) was observed in the two high bonding social capital communities, each displaying intra-community trust to adapt to the aftermath of the storm by equally sharing resources and quickly accessing hard to reach residents through patchwork road access and door-to-door neighbor checking. High bonding social capital communities displayed resilience by not requiring outside resources to achieve community stability, which is consistent with recovery efforts after Hurricane Sandy (Cagney et al., 2016), and with regards to local governments after Hurricane Katrina (Weil et al., 2012).

In the low bonding/low bridging community of Plymouth, where a lead central actor played a critical role in coordinating relief efforts, a brokered network structure used their intra-bonding social capital to activate bridging social capital, which helped forge a shared sense of place – the idea of the organization and community members as neighbors and should take care of one another –as observed with free cooked meals at town hall, and the amassed volunteer force helping recovery efforts in the weeks after TSI. The sudden bridging social capital fostered enough of a bond between community members who previously had weak or strained ties that immediate food security needs were addressed. The bridging social capital temporarily set the norms, understandings, and expectations about the interactions of groups (Ostrom, 2000) after TSI. This is consistent with research observing independent neighborhood communities using social bonds as resilience after Hurricane Sandy (Clay et al., 2016). Though it is possible Plymouth community members would have responded differently without a central actor, the created bridging social capital by a lead organization suggest that a prior low bonding/low bridging community does not pre-determine cooperation and informal social cohesion (i.e. community members showing up at town hall for cooked meals) and can create sufficient community resilience (Cagney et al., 2016) as seen with the response to community food security after TSI.

One key finding of this work also suggests the importance of "sense of place", and the way in which social capital may interact with other forms of capital (e.g. physical, manufactured, etc.). The subjects' perception of social capital by name was not strictly assessed from the reported actions and depictions of community responses to TSI. Underlying positive perceptions of social capital is the notion of a community being "special". This idea surfaced in nearly all the interviews of each of the three focus communities – Pittsfield, Plymouth, and Rochester – with differences between interviewees sense of place, which appear to be related to social capital. The high social capital communities (Pittsfield, Rochester) attributed their feelings about the specialness of their community to the town location, size (low population), and/or the public and private infrastructure (businesses, town centers, schools, etc.). The low social capital community (Plymouth)

felt “people” make a place special; interesting considering the low social capital community also had a lack of infrastructure, the size of the town relative to the vacant housing (Table 2), and the decreased community involvement prior to TSI.

It has been shown that individual social connectedness and sense of place are positively linked to individual resilience in rural areas (Boon, 2014). The stronger a sense of place is felt by individuals within a community, and the more social capital a community is perceived to have, the more that community will remain stable in population and socio-economic indicators. While our study generally agrees with this idea, what remains to be understood is if a community's sense of place increases social capital, or does social capital heighten a sense of place? To put this in terms used for the research subjects, it is the place or the people that make a place “special”?

Our findings also suggest a connection between social capital and physical capital, as indicated by our interviewees as being necessary to foster the continuation of social capital. The two communities with pre-EWE high levels of bonding and/or bridging social capital (Pittsfield, Rochester) had more available private and public infrastructure than the community with pre-EWE low levels of social capital (Plymouth) (see Table 2). In the high bonding (Pittsfield) and high bonding/high bridging (Rochester) social capital communities, physical places such as locally accessible restaurants and food stores, centralized town greens, and (in the case of Rochester) public schools and food pantries not only contributed to a sense of place, but also became the central locations where by organized community led recovery efforts happened. These findings are consistent with other studies suggesting though high levels of physical capital have been recognized for community disaster related preparedness, it is community social capital that can often improve the community resilience and adaptation usage of the physical capital (Eriksson et al., 2017; Hamilton et al., 2003) Based on our findings, we theorize that a sense of place has an effect on the level of bonding social capital within the community. The higher the level of bonding social capital within a community, the more that community is to have access to physical capital (i.e. schools, local businesses, public parks). Similar observations in the efficiency of disaster response and communication showed that relations between institutional actors had a more positive effect on disaster response when the interactions shaped the structure, and therefore the response, of the institution (Nowell and Steelman, 2014). In our study, physical capital is connected with high bonding social capital as it appears that bonding social capital is well suited for community resiliency and adaptation to meet acute needs caused or worsened by an EWE.

Drawing upon social network theory (Provan and Kenis, 2007), these findings also suggest that different community structures, and resulting levels of community social capital, may have strongly affected the post EWE responses (Casagrande el al., 2015). Shared networks of governance are demonstrated in Pittsfield and Rochester where multiple actors seemed to come together, albeit with different levels of inward or outward facing capital. In Pittsfield, existing bonding social capital was more responsive to immediate needs and short-term recovery due to already established intra-community trust between a core group of town officials, business owners, and community leaders who acted to address community food security issues. Because trust and reciprocity were established prior to TSI, bridging social capital stemming for a lead organization (as observed in Plymouth) was not necessary - that role in Pittsfield was informally filled with community members taking care of each other. In Rochester, both bonding and bridging social capital allowed trust and information to spread quickly and effectively to intra and extra community groups as their immediate post-TSI food security needs were abundantly met. This is because the town government, acting as a central actor, worked in tandem with other intra and extra community groups resulting in everyone within the Rochester network to address acute community food insecurity. Both Pittsfield and Rochester had infrastructure such as an active school, local businesses, and centralized public space (town centers, town greens). Using social network analysis in combination with the type of social capital (bonding and bridging), and the elements supporting the creation of social capital, can provide a step toward untangling the complexity of social networks and social capital at the community level (Mandarano, 2009).

Our findings suggest that building community social capital in rural areas could be critical for future climate change adaptation and resilience. Networking organizations and community leaders connecting with community actors and stakeholders is well-established as critical for successful community development (Agnitsch et al., 2006; Perkins and Court, 2005) and disaster resilience (Jung and Song, 2015), including during EWE (Wistow et al., 2015). Community development can promote a positive sense of place through public institutions, local government involvement, locally owned and operated economies, and open public events focused on the community. Such results are especially important for rural communities. Since 2007, U.S. rural communities have experienced population loss, increased poverty rates, and lower employment growth rates than non-rural U.S. communities (USDA ERS, 2016a,b,c). Rural communities and small towns often do not have the necessary capital investments to build large-scale food security infrastructure, fund public schools, attract local business investments, and hold community focused public events. By neglecting community development as a social capital building mechanism, it can render existing low social capital communities more vulnerable to future climate impacts and EWE. However, not all community development promotes social capital and some development decreases public space and infrastructure (Salamon, 2003), therefore rural development that is place centered (sense of place) is likely to promote social capital building. Our study suggests that fostering the development of social capital, both bridging and bonding, is beneficial to rural communities in building resilience and adaptation for effective community responses to EWE and climate impacts.

Our work further contributes to the call for greater social science research to facilitate resilience in disaster recovery (Aldrich and Meyer, 2015; Aldrich, 2017; Weil et al., 2012). Future research can further explore relationships between social capital and rural infrastructure investments by bringing in quantitative and qualitative data on social capital and a sense of place. Possible areas to investigate are economic development in relation to the locations of rural communities (bedroom communities near city centers vs. more distant, stand-alone towns). Future studies can look at the physical capital of business types (locally owned vs. corporate owned), new business development (tourism, resource extraction, manufacturing), and public infrastructure (schools, parks, and roads) to investigate how these influence community social capital before and after EWE. We suggest that additional research in rural regions across the U.S. should be conducted to see if variations in culture, demographics, landscape, resources, and regional history affect social capital's response to extreme events that disrupt local food systems. Expansion of our research would include correlating the above variations of social capital before and after EWE with a sense of place, a concept needing further attention in empowering rural development (Bell et al., 2014) and expanding rural social sciences (Bell, 1997). Future studies can be conducted within urban areas to see if social cohesion within city neighborhoods and/or districts can benefit from social capital as means to adaptation and resilience in the face EWE.

We note a few limitations of this research design. Obviously, the focus is VT specific, and can only speak about those who experienced TSI and food security issues in VT. The study can only peripherally indicate bridging social capital outside of the town and bonding social capital from one VT town to another. Neighboring states and Canada (along VT's north border) were likely to have contributed to the event and subsequent recovery. Further, though we discuss associations between social capital and TSI response, given the nature of the study design, we cannot indicate a directional association between social capital and the response to TSI.

Though all interviews were confidential, some interviewees may

have social desirability bias, especially if they were a public official at the time. Furthermore, since many of the interviewees were prominent leaders within the community, it is possible that the perspectives captured here may be more representative of community leaders than community residents. However, many interviewees considered themselves a resident first, and their respective community role second. Lastly, the study used a small sample size (n = 33) from four communities in the state. The study's limitations make generalization beyond rural VT only suggestive of future research on food security issues caused or worsened by EWE in the rural U.S.

7. Conclusion

This study adds to the body of work on social capital and disaster response and is among the first to explore the influence of social capital on U.S. rural community responses to an EWE, *and* its impact on *community* food security. After TSI in VT, both bonding and bridging social capital influenced rural community responses to a EWE, which led to effective action improving and stabilizing community food security. Our findings indicate that the rural communities with high levels of bonding social capital facilitated a collective community response to short-term community food security during and after a EWE. Communities with high bonding social capital prior to a EWE were effective at quickly implementing strategies to provide food and services to those both within the community. The community with both high bonding and high bridging social capital could extend post-EWE food and services to those outside of the community. However, prior levels of social capital did not inhibit a collective community response. The community with low levels of bonding and bridging social capital prior to TSI was able to engage bridging social capital through a local organization emerging as a central actor in disaster recovery related to food security. On the strength of the central actor's quick use of organization networks and bridging social capital, the community could mitigate acute food security issues during and after a EWE. Both social capital and network theory suggest that absent a central organization to create community resiliency and adaptation by way of bridging social capital, communities with low social capital may have been less effective at mitigating acute food security issues after a EWE. Based on our findings, we suggest that rural communities without high bonding and/or bridging social capital prior to a EWE may have less community resilience and adaptation for short-term food security issues after a EWE than communities with high bonding and/or bridging social capital, unless the low social capital communities are able to engage an accessible network with a central actor able to utilize bridging social capital to bring the community together at the time of the EWE. We also suggest that low social capital communities are more likely to be reliant upon outside government agencies and non-governmental organizations to provide short-term food security than high social capital communities. Comparative studies between rural communities, including those that did not experience high social capital during and after an EWE, are needed.

Our findings also suggest a significant connection between social and physical capital, manifested in a “sense of place”. Bonding and bridging social capital associate in relation to a community's sense of place. In our study, the communities with high levels of boding social capital prior to TSI had a distinct sense of place; community members were more likely to view their community as “special” because of the physical location of the town *and* the people within the community than communities with lower levels of social capital prior to the EWE. The community with low bonding and bridging social capital prior to TSI mainly view people, and not the location, as to what makes a place “special”. The low bonding social capital community prior to TSI lacked public infrastructure (i.e. open public school), a vibrant local economy (empty commercial buildings), community focused local events, and had higher percentage of vacant homes (referred to as “second home owners”) compared to the communities with high bonding social capital prior to TSI. Emerging from our study is a hypothesis that social and physical capital are deeply intertwined, and when coupled together could influence disaster recovery and climate adaptation. As such, we suggest that promoting the development of bonding social capital within rural communities through place-centered development - creation of public events, investment in public infrastructure such as schools and parks/town greens, and the promotion of locally owned and operated businesses - can build resiliency and adaptation to future EWEs. Rural development could place more focus on physical capital to facilitate to creation of bonding social capital as a preparedness strategy for mitigating short-term issues such as food security, in the face of future climate change induced EWEs. Future research can explore relationships between perceived social capital and rural development and physical capital investments as it relates to climate change adaptation and resilience in rural communities. Above we have provided potential indicators to explore these factors in greater context in future social capital, climate change, and rural development research.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jrurstud.2018.09.019.

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